

Title: Soliton solutions for conventional breakdown in air: implications for stepped leaders

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Abstract:

Numerous studies have been carried out over the past several decades regarding the physics of electrical breakdown and discharge that involve various degrees of approximation. Many of these studies employ numerical solutions of the relevant dynamical equations. Recent results point to the existence of well localized cloud of charge that propagates as a self-similar ensemble until its initial stored energy has been dissipated through ionization, attachment, recombination and radiation (e.g. Lowke [IEEE TPS, 2004]). In this work we present an analytic treatment of electrical breakdown and charge propagation using the ionization kinetics of Lowke [J Phys D, 1992] and a simple approximation for the drift velocity of electrons. We find explicit soliton solutions for simple geometries of the fully nonlinear set of dynamical equations. Our results are compared to previous studies in detail and the implications of this work for leader propagation and ball lightning will be assessed.